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ORIGINAL ARTICLE

Prevalence of metabolic syndrome in young adults: a risk factor for future cardiovascular disease

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ABSTRACT

Aim To investigate a correlation between metabolic syndrome, especially waist circumference, and cardiovascular risk in young adults.
Methods This retrospective cohort study included 137 patients under 50 years of age who visited the Family Medicine Service of Tuzla Health Centre. Data were collected from patient records and through physical examination. The National Institutes of Health Guidelines definition of MetS was used. For participants over 40 years of age, the 10-year cardiovascular risk was calculated using SCORE2 tables.
Results A total of 137 young adults participated in the study, with 66.4% females and 33.6% males. Mean BMI was 26.45±4.69 kg/m², and 60.6% were overweight or obese. The prevalence of metabolic syndrome was 29.93%. Waist circumference showed a moderate positive correlation with cardiovascular risk (r=0.40; p<0.001). Among participants under the age of 40, 20% already had metabolic syndrome, and 20% exhibited two or more risk factors.
Conclusion The study found a high prevalence of metabolic syndrome in young adults, with those diagnosed exhibiting a higher cardiovascular risk. Increased waist circumference was associated with higher cardiovascular risk. A significant proportion of participants under 40 showed cardiovascular risk components, emphasizing the need for early risk assessment in this age group. Early screening, particularly waist circumference measurement, is crucial for identifying those at risk and promoting lifestyle changes to reduce cardiovascular diseases.
Keywords: metabolic syndrome, cardiovascular risk, waist circumference
Keywords: glucose metabolism disorders, lipid metabolism disorders, waist circumference

INTRODUCTION

The metabolic syndrome (MetS) is a set of interrelated metabolic abnormalities, including central obesity, dyslipidaemia, hypertension, and glycaemic disturbances, which significantly increase the risk of developing cardiovascular disease (CVD) and type 2 diabetes. According to the definition of the International Diabetes Federation (IDF), the key diagnostic criterion for MetS is increased waist circumference, which reflects central adipocyte dysfunction and is associated with insulin resistance (1). This syndrome is globally recognized as one of the most important public health problems of the 21st century. The prevalence of metabolic syndrome is estimated to range from 10% to 30%, with a marked increase observed in older age groups across most European countries (2).

The prevalence of MetS among young adults is increasing due to modern lifestyles, which include increased consumption of high-energy foods and decreased physical activity (3). Although metabolic syndrome is most often studied in the elderly population, there is increasing evidence that young people are also at significant risk of developing cardiovascular disease due to the presence of MetS (4). Early detection and intervention in young people with MetS can play a key role in preventing future cardiovascular events (5).

The current obesity epidemic represents a significant public health challenge of the 21st century (6). Obesity is an independent risk factor for CVD, and is associated with many CVD comorbidities (7). As a serious public health problem worldwide, obesity affected a total of 107.7 million children and 603.7 million adults from 195 countries in 2015, resulting in 4.0 million deaths and 120 million disability-adjusted life years among adults worldwide. CVD was the leading cause of death and disability-adjusted life years associated with obesity (8). Body Mass Index (BMI) is a common indicator for the definition of obesity. However, this does not reflect the location of fat distribution, and conclusions about the relationship between BMI and CVD are inconsistent. Coutinho et al. found that the risk of death decreased with increasing BMI in 15,923 patients with coronary artery disease, while abdominal obesity was positively associated with mortality (9).

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The best indicator of abdominal obesity is waist circumference (WC). Waist circumference has attracted particular attention as a simple, but significant marker of abdominal obesity and future cardiovascular risk. Increased waist circumference is strongly associated with increased levels of visceral fat, which plays a key role in the development of atherosclerosis and other cardiovascular complications (10). In a meta-analysis that included 31 studies with a total of 669,560 participants it was found that a 10 cm increase in waist circumference can increase the risk of cardiovascular disease by 3.4% in females and 4.0% in males (11). In a prospective cohort study with 1,521 participants, it was found that patients with an increased waist circumference (over 94 cm) who had diabetes had a significantly increased risk of cardiovascular death (hazard ratio: 3.78). These findings suggest that waist circumference may provide additional prognostic value beyond traditional risk factors (12). Research which showed that WC was a better predictor of cardiovascular risk in females, while BMI was a better predictor in males. The recommended WC thresholds are 89 cm for females and 102 cm for males, and these thresholds are associated with a higher risk of cardiovascular disease (13). Research into the prevalence of MetS in ay oung adult population may provide important information about its impact on cardiovascular health in the future.

In Bosnia and Herzegovina there are only limited data on MetS prevalence among young adults. Most existing studies focus on older population.

The aim of the study was to investigate the prevalence of MetS in a young adults and analyse its association with waist circumference as a marker of abdominal obesity and cardiovascular disease risk. The results of this work contribute to better understanding of metabolic and cardiovascular risks in the younger population, which aims to develop targeted preventive strategies.

PATIENTS AND METHODS

Patients and study design

This retrospective cohort study included 137 patients <50 years of age who visited the Family Medicine Service of Tuzla Health Centre for regular check-ups between June and September 2024. Routine medical examination performed to monitor their general health status, identify risk factors early, and prevent the development of chronic diseases: assessment of vital signs, physical examination, laboratory tests (such as blood glucose and lipid levels), and measurement of anthropometric parameters like WC and BMI. The exclusion criteria consisted of patients aged ≥50 years as well as those with incomplete or unavailable medical records, patients with serious acute or chronic conditions (such as cancer or severe infections).

Methods

Data were collected from patient's medical records. Physical examination data documented during previous regular visits included measurements of height, weight, waist circumferences, both systolic and diastolic blood pressure. Height was measured with a stadiometer and weight with mechanical weighing scale (Seca GmbH, Hamburg, Germany). Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Waist circumference was calculated midway between iliac crest and lowest rib and measured using a tape measure; it was considered elevated in females >89 cm and in males >102 cm. Blood pressure was measured using a sphygmomanometer in sitting position after 5 min rest: the average of the three readings of systolic and fifth Korotkoff diastolic sound were used as the measure of blood pressure. The current use of antihypertensive medication was considered as an indication of high blood pressure. Data on smoking, family history, education and comorbidities were obtained from the patient's medical records.

Venous blood was sampled after 12 hours of fasting for the measurement of plasma concentrations of glucose, and serum concentrations of total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) and triglycerides.

The National Institutes of Health guidelines were used to define metabolic syndrome (14). For participants over 40 years of age, the 10-year risk of a cardiovascular event was calculated using SCORE2 tables (15) and stratified into three categories: low risk (<2.5%), moderate risk (2.5 to <7.5%), and high risk (≥7.5%).

The definition of the metabolic syndrome by the National Institutes of Health guidelines involved three or more of the following traits: a waistline that measures at least 89 centimetres for females and 102 centimeters for males, serum triglycerides ≥1.7 mmol/L, HDL cholesterol <1.04 mmol/L in males or <1.3 mmol/L in females, blood pressure ≥130/85 mm Hg or treatment for hypertension, and elevated fasting blood sugar ≥5.6 mmol/L.

Statistical analysis

Descriptive statistics were employed to outline demographic and clinical features. For parametric data, the Student's t-test and Pearson's correlation coefficient (r) were applied. For non-parametric data, the following tests were utilized: the Mann-Whitney U test, Spearman's correlation coefficient, and the $\chi 2$ test. A p<0.05 was considered statistically significant.

RESULTS

A total of 137 young adults (mean age 41.96±5.56 years) participated in the study, of which 91 (66.4%) were female, and 46 (33.6%) were male. Overall mean BMI was 26.45±4.69 kg/m², with 83 (60.6%) participants classified as overweight (BMI ≥25 kg/m²) or obese (BMI ≥30 kg/m²). The prevalence of the metabolic syndrome was 29.93% (n = 41), as defined by the presence of at least three of the National Institutes of Health guidelines defined characteristics.

The mean total cholesterol level was 5.31±1.02 mmol/L, with 62 (45%) participants exhibiting levels above the recommended. The mean LDL cholesterol level was 3.12±0.92 mmol/L, and 52 (38%) participants had high LDL level. Conversely, the mean HDL cholesterol was 1.46±0.43 mmol/L, with 55 (40%) participants presenting with a level below the protective threshold of 1.04 mmol/L for males and 1.3 mmol/L for females. The mean triglyceride concentration was 1.67±1.39 mmol/L, with 44 (32%) participants exceeding the 1.7 mmol/L cutoff for high triglyceride level.

The number of participants whose blood pressure met the criteria for hypertension (SBP ≥140 mm Hg or DBP ≥ 90 mm Hg) was 37 (26.67%).

Correlation between the components of the metabolic syndrome were significant. BMI was positively correlated with triglycerides (r=0.30; p<0.001) and blood glucose (r=0.42; p < 0.001), while negatively correlated with HDL cholesterol (r= -0.44; p < 0.001) (Table 1).

Table 1. Correlation between body mass index (BMI) and components of metabolic syndrome in 137 participants

BMI	Triglycerides	Blood glucose	HDL cholesterol
r	0.301	.416	-.444
p	< 0.001	< 0.001	< 0.001

Participants with metabolic syndrome had significantly higher BMI (30.33±4.55 kg/m² vs. 24.79± 3.67 kg/m²; p<0.001), triglycerides (2.58±1.82 mmol/L vs. 1.28 ± 0.98 mmol/L; p<0.001), and blood glucose (5.69±0.69 mmol/L vs. 5.22±0.56 mmol/L; p < 0.001), while there were no statistically significant differences in LDL values (3.25±1.01 vs. 3.11±0.89 mmol/L; p=0.391) compared to participants without metabolic syndrome. The HDL cholesterol level was significantly lower in participants with metabolic syndrome (1.13 ± 0.28 mmol/L vs. 1.60±0.40 mol/L; p<0.001) (Table 2).

Table 2. Association between clinical variables and metabolic syndrome (MS) status

Variable	Mean±SD		p
	Patients with MS	**Patients without MS**	
Age (years)	43.24±6.26	41.42±5.15	0.021
BMI (kg/m²)	30.33±4.55	24.79±3.67	< 0.001
Triglycerides (mmol/L)	2.58±1.82	1.28±0.98	< 0.001
Blood glucose (mmol/L)	5.69±0.69	5.22±0.56	< 0.001
LDL cholesterol values (mmol/L)	3.25±1.01	3.11±0.89	0.391
HDL cholesterol values (mmol/L)	1.13±0.28	1.60±0.40	<0.001
Cardiovascular risk (%)	3.79±3.08	1.811.64	<0.001

BMI, Body Mass Index; LDL, Low-Density Lipoprotein cholesterol; HDL, High-Density Lipoprotein cholesterol

Comparison of clinical variables between participants with low and moderate cardiovascular risk showed statistically significant differences in all variables: age (p<0.001), BMI (p<0.05), WC (p<0.001), and blood glucose level (p=0.029) (Table 3).

Table 3. Comparison of clinical variables between individuals with low and moderate cardiovascular risk

Variable	Low cardiovascular risk	Moderate cardiovascular risk	p
	Mean±SD		
Age (years)	43.40±2.65	45.89±3.12	<0.001
BMI (kg/m²)	25.50±4.28	29.01±4.68	<0.05
Waist circumference (cm)	83.79±16.03	97.96±12.46	<0.001
Blood glucose (mmol/L)	5.31±0.63	5.71±0.77	0.029

Statistically significant differences were observed in age (p < 0.05), with the high-risk group being older, while BMI, WC, and blood glucose level showed no significant differences between the two groups (p>0.05) (Table 3).

Waist circumference exhibited a moderate positive correlation with cardiovascular risk (r=0.40; p<0.001), indicating that larger waist circumference is associated with an increased risk of cardiovascular disease.

Table 4. Comparison of clinical variables between individuals with low and high cardiovascular risk

Variables	Mean±SD		p
	Low cardiovascular risk	**High cardiovascular risk**	
Age (years)	43.40±2.65	48.00±1.41	<0.05
BMI (kg/m²)	25.50±4.28	27.66±2.39	0.075
Waist circumference (cm)	83.79±16.03	96.60±10.55	0.075
Blood glucose (mmol/L)	5.31±0.63	5.16±0.39	0.455

Of the total number of participants, 30 (23.36%) were <40 years old and they were not included in the current SCORE2 tables for calculating the 10-year cardiovascular risk, and six (20%) already had a diagnosis of metabolic syndrome. A total of 18 (40.60%) participants <40 years of age showed elevated non-HDL value (mean 3.57±0.99 mmol/L), which is one of the main components of calculating cardiovascular risk. Also, six (20%) participants exhibited other components of cardiovascular risk such as smoking and hypertension, in seven (23.33% and six (20%) participants, respectively.

DISCUSSION

The prevalence of MetS of 29.9% among young adults (up to 50 years of age) in primary health care settings was determined in this study. Moreover, in the subgroup of participants younger than 40, the prevalence of MetS was 20%, with more than half already being overweight or obese, which aligns with recent data showing a notable increase from around 16% at the beginning of the decade (16). Given that central obesity is a core component of MetS, it is not surprising that most young adults who develop MetS are overweight or obese. For example, one analysis of young adults aged 20–40 reported that over 80% of those with MetS were in the obese BMI range (17). These findings indicate that a significant proportion of the youth population already meets the criteria for MetS, which is of concern in terms of future cardiovascular risk. We also found that BMI was statistically significantly correlated with components of the metabolic syndrome - positively with triglycerides and blood glucose level, and negatively with HDL-cholesterol concentration. Participants with MetS had significantly more disadvantaged cardiometabolic profile, higher average BMI and blood pressure, higher triglycerides and glycemia and lower HDL cholesterol, compared to those without MetS. Notably, low HDL cholesterol appears to be the most common MetS component in young adults. A large meta-analysis observed that among 18–30 year-olds, low HDL was the most prevalent abnormality (affecting ~27–41%) even more than elevated blood pressure or high triglycerides. This suggests that many young people begin showing lipid warning signs before full MetS develops. Overall, our finding that the MetS group is metabolically worse off is expected and corroborated by the literature (16,18, 19). Several studies support our finding that WC is positively correlated with estimated ten-year cardiovascular risk, for instance, a study which analysed 2,061 patients using the new SCORE2 algorithm for 10-year CVD risk. They found that both BMI and WC independently predicted an above-average 10-year risk; notably, WC was a particularly strong predictor in women (13).

The prevalence rate of MeTs in our cohort is consistent with recent global findings. Global studies show that MeTs affects approximately 5–7% of healthy young adults (18–30 years) (16). In Iran, for example, a similar range of about 6–10% has been reported in young people (20). In contrast, our rate of 20% in the population <40 years is significantly higher, which can be partially explained by the inclusion of participants in the third and fourth decades of life when the prevalence begins to rise. Interestingly, our results are comparable to data from the USA, where about one fifth of adults aged 20 to 39 have metabolic syndrome (21). A meta-analysis of cardiovascular risk association with MeTs in 951,083 patients showed that metabolic syndrome is associated with an increase in cardiovascular outcome and mortality (22). This indicates that MetS has become widespread in younger age groups in different populations and now it is not just a problem of old age.

The association of BMI and abdominal obesity with cardiovascular risk that we observed was also confirmed in other studies (23). Consistent with our findings, a recent study reported that high waist circumference (≥102 cm for males and ≥88 cm for females) was strongly correlated with MetS. Furthermore, elevated blood pressure, elevated fasting glucose, and elevated fasting triglycerides were significantly more common in the high waist circumference group, than in the non-high waist circumference group (24). A recent study showed that every 10 cm increase in waist circumference is associated with a ~45% higher risk for cardiovascular disease, as well as an ~8% higher overall mortality rate (25). These findings emphasize that central obesity is a key driver of cardiovascular risk, which is also reflected in our study (26).

It has been noted that the presence of even just one component of MetS at a young age significantly increases the likelihood of later development of the full syndrome and carries a greater lifetime burden of cardiovascular risk (16). Young people with metabolic disorders have a greater chance of developing type 2 diabetes and cardiovascular disease in middle age. Some research suggests that the MetS, not just BMI, is a better predictor of future cardiovascular events (27). Our observation that young adults with MetS already exhibit clustered risk factors is consistent with other studies, and implies that, without early intervention, this population is likely to have an increased burden of cardiovascular disease in the future.

This study has several limitations that should be acknowledged. First, the relatively small sample size of 137 participants may limit the statistical power and the ability to detect subtle associations between variables. Second, the study was conducted in a single institution, which may introduce selection bias and restrict the generalizability of the findings to broader populations. Finally, some relevant confounding factors, such as detailed dietary intake, physical activity, socioeconomic status, and family history, were not comprehensively assessed, which may have influenced the observed associations.

This study represents one of the rare insights into MetS in young adults in Tuzla region, especially in the context of primary health care settings. These results should serve as a call to action: early identification and treatment of MetS in younger adults may play the critical role in preventing future cardiovascular events (28).

In conclusion, the scientific novelty of our work is reflected in the quantification of the relationship between waist circumference as the component of MetS and cardiovascular risk in the population under 40 years of age, demonstrating that patients with diagnosed MetS had a higher 10-year risk of cardiovascular events. The practical implication of these findings is that clinicians should pay more attention to cardiovascular and metabolic risk profiles even in apparently "healthy" young patients. Waist circumference remains one of the most practical, cost-effective, and accessible clinical tools for identifying visceral obesity and associated metabolic disturbances. Its simplicity, reproducibility, and strong correlation with cardiometabolic risk factors make it especially valuable for early detection and routine cardiovascular risk assessment. The results suggest that lifestyle modifications aimed at reducing central obesity, as reflected by waist circumference, could significantly improve metabolic health and lower the risk of cardiovascular diseases, which indicates the need to develop simple tools or scores for the early assessment of cardiovascular risk in people under 40 years of age. The fact that one in five young adults in our study and others already meets MetS criteria is a red flag that without intervention, this cohort could fuel a wave of premature cardiovascular events in the coming decades.

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TRANSPARENCY DECLARATION

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